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YELLOWFIN TUNA SPAWNING IN THE CENTRAL EQUATORIAL PACIFIC

By Heeny S. H. Yuen and Fred C. June

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ABSTRACT

Material for this report was furnished by 740 laboratory determinations, supplemented by field determinations, of the stage of maturity of ovaries of yellowfin tuna (*Neothunnus macropterus*) caught in the central equatorial Pacific. The usual length at sexual maturity of yellowfin in this area was found to be about 120 cm., although yellowfin as small as 70 cm. may be mature. Spawning was found to occur throughout the area surveyed (approximately 10° N. to 8° S. latitude, 120° W. to 180° longitude). Other studies have indicated that this area is but part of a band of yellowfin spawning grounds which covers the entire equatorial Pacific.

In this investigation, residual eggs in various stages of resorption were examined and described. Of 25 ovaries examined, 22 were found to be infested with unidentified nematodes ranging from 0.5 to 4 cm. in length. The number of worms in an ovary was usually less than five, and the infestation did not appear serious enough to affect the function of the ovary.

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YELLOWFIN TUNA SPAWNING IN THE CENTRAL EQUATORIAL PACIFIC

By HEENY S. H. YUEN and FRED C. JUNE, *Fishery Research Biologists*

Because of the need for more knowledge about he spawning habits of the yellowfin tuna, *Neo-hunnus macropterus* (Temminck and Schlegel), a tudy was initiated as part of the tuna-research rogram of the Fish and Wildlife Service's Pacific)ceanic Fishery Investigations (POFI). Previous tudies have been made of the reproduction of his species in various parts of the Pacific—by chaefer and Marr (1948) and by Mead (1951) in Central American waters, by Bini (1952) off Chile nd Peru, by June (1953) in Hawaiian waters, by Marr (1948) in the Marshall Islands, by Shimada 1951) near Kapingamarangi Island (1° N., 155° .), and by Wade (1950 and 1951) in the Philip-ine Islands. This report is based on data from he central equatorial Pacific.

In this study we have investigated the time and lace of spawning and the size of the fish at sexual naturity. Stages in the resorption of ripe eggs hat were not spawned are incidentally described. The appearance of nematodes in the ovaries is oted, and its effect on egg production is discussed.

The research staff and vessel personnel assisted n the collection of ovaries and field data; Richard homura helped process the ovaries; Wilvan Van Campen translated the Japanese data; and Tamotsu Nakata prepared the illustrations.

SOURCES OF DATA

Ovaries collected on POFI exploratory-fishing rips from February 1950 to June 1954 provided nost of the material for this study. The area of ollection extended from 8° S. to 10° N. latitude nd from 120° W. to 180° longitude.

The ovaries, preserved in 10-percent formalin, were brought back to the laboratory for examination. A record was kept of the date and the place of capture and the fork length of each fish. At the laboratory, the eggs were classified according to physical characteristics, as immature, intermediate, maturing, or ripe, as defined by June (1953). The "spawned out" category was omitted because of the difficulty in defining this class, but since only a fraction of the total number of eggs is emitted during spawning the remaining eggs permitted fish that had recently spawned to be classified into one of the four categories.

The principal features of the four categories are as follows:

Immature.—The eggs are translucent and range from 0.01 to 0.18 mm. in diameter.

Intermediate.—The largest eggs are semiopaque owing to the deposition of yolk granules; the diameters range from 0.18 to 0.40 mm.

Maturing.—The largest eggs are fully opaque, with diameters ranging roughly from 0.40 to 1.00 mm.

Ripe.—The largest eggs are transparent and loose, with diameters of about 0.76 to 1.23 mm. A prominent oil globule is present in each egg.

The ovaries collected after 1951 were subjected to an added procedure in the laboratory. They were examined for residual eggs—ripe eggs of a previous spawning that were not expelled. These eggs were classified as being in the early stages of resorption if they were still translucent and loose, and as being in the late stages if they were massed together and opaque or turning opaque.

The laboratory classifications of the ovaries are arranged in table 1 by month and locality of capture, by stage of maturity, and by length of fish.

TABLE 1.—*Data on 740 yellowfin tuna specimens from the central equatorial Pacific for which maturity determinations were made in the laboratory*

[Data are grouped by month of capture, by sections of 10 degrees of longitude (115° W. to 125° W., etc.), by stage of maturity, and by fish length]
[Im=immature, In=intermediate, M=mature, R=ripe]

Date	Position		Stage of maturity	Fish length
	Latitude	Longitude		
				Cm.
Jan. 26, 1951	5°37′ S.	154°56′ W.	M	113
Jan. 27, 1951	4°03′ S.	154°59′ W.	Im	104
Do	4°03′ S.	154°59′ W.	Im	96
Jan. 26, 1951	5°37′ S.	154°56′ W.	Im	78
Jan. 31, 1953	1°52′ N.	156°41′ W.	M	143
Do	1°52′ N.	156°41′ W.	In	146
Jan. 23, 1953	5°55′ N.	162°19′ W.	In	135
Do	5°55′ N.	162°19′ W.	In	132
Jan. 25, 1953	5°46′ N.	162°06′ W.	In	127
Do	5°46′ N.	162°06′ W.	Im	133
Do	5°46′ N.	162°06′ W.	Im	119
Jan. 21, 1951	0°01′ N.	158°17′ W.	Im	85
Jan. 19, 1951	8°30′ N.	158°21′ W.	Im	83
Jan. 27, 1953	5°53′ N.	161°15′ W.	Im	66
Jan. 26, 1951	3°07′ S.	171°05′ W.	In	98
Jan. 31, 1951	3°35′ S.	171°31′ W.	In	93
Jan. 26, 1951	3°07′ S.	171°05′ W.	Im	91
Do	3°07′ S.	171°05′ W.	Im	78
Jan. 29, 1951	4°26′ S.	171°15′ W.	Im	68
Feb. 11, 1953	0°09′ N.	150°00′ W.	M	149
Feb. 4, 1953	2°07′ N.	150°09′ W.	M	148
Feb. 4, 1952	0°02′ S.	154°57′ W.	M	147
Feb. 14, 1953	1°19′ S.	150°36′ W.	M	146
Feb. 12, 1953	1°13′ S.	150°11′ W.	M	145
Feb. 4, 1953	2°07′ N.	150°09′ W.	M	143
Feb. 12, 1953	1°13′ S.	150°11′ W.	M	143
Feb. 13, 1953	1°19′ S.	150°24′ W.	M	143
Feb. 4, 1953	2°07′ N.	150°09′ W.	M	139
Do	2°07′ N.	150°09′ W.	M	138
Feb. 12, 1953	1°13′ S.	150°11′ W.	M	138
Do	1°13′ S.	150°11′ W.	M	138
Feb. 13, 1953	1°19′ S.	150°24′ W.	M	137
Feb. 4, 1952	0°02′ S.	154°57′ W.	M	135
Feb. 3, 1953	2°54′ N.	150°19′ W.	In	152
Feb. 13, 1953	1°19′ S.	150°24′ W.	In	150
Feb. 4, 1952	0°02′ S.	154°57′ W.	In	148 or 140
Feb. 4, 1953	2°07′ N.	150°09′ W.	In	142
Feb. 13, 1953	1°19′ S.	150°24′ W.	In	142
Feb. 3, 1953	2°54′ N.	150°19′ W.	In	141
Feb. 10, 1953	1°04′ N.	151°05′ W.	In	141
Feb. 1, 1952	4°04′ N.	154°56′ W.	In	140
Feb. 17, 1953	2°56′ S.	150°08′ W.	In	138
Feb. 2, 1953	3°49′ N.	150°07′ W.	In	136
Feb. 1, 1952	4°04′ N.	154°56′ W.	In	129
Do	4°04′ N.	154°56′ W.	In	128
Feb. 2, 1953	3°49′ N.	150°07′ W.	Im	140
Feb. 19, 1953	6°08′ S.	150°09′ W.	Im	136
Feb. 1, 1952	4°04′ N.	154°56′ W.	Im	126
Do	4°04′ N.	154°56′ W.	Im	123
Do	4°04′ N.	154°56′ W.	Im	118
Do	4°04′ N.	154°56′ W.	Im	114
Do	4°04′ N.	154°56′ W.	Im	108
Feb. 5, 1952	1°20′ S.	155°06′ W.	M	148
Feb. 3, 1953	1°59′ N.	157°31′ W.	M	148
Feb. 5, 1952	1°20′ S.	155°06′ W.	M	147
Do	1°20′ S.	155°06′ W.	M	143
Feb. 3, 1952	1°20′ N.	155°03′ W.	M	142
Feb. 5, 1952	1°20′ S.	155°06′ W.	M	139
Feb. 3, 1953	1°59′ N.	157°31′ W.	M	139
Do	1°59′ N.	157°31′ W.	M	138
Do	1°59′ N.	157°31′ W.	M	134
Feb. 1, 1953	1°57′ N.	157°32′ W.	M	133
Feb. 3, 1953	1°59′ N.	157°31′ W.	M	130
Feb. 3, 1952	1°20′ N.	155°03′ W.	M	126
Feb. 3, 1953	1°59′ N.	157°31′ W.	M	124
Feb. 5, 1952	1°20′ S.	155°06′ W.	M	76
Feb. 1, 1953	1°57′ N.	157°32′ W.	In	142
Feb. 5, 1952	1°20′ S.	155°06′ W.	In	140
Feb. 3, 1953	1°59′ N.	157°31′ W.	In	140
Do	1°59′ N.	157°31′ W.	In	138
Feb. 5, 1952	1°20′ S.	155°06′ W.	In	137
Feb. 2, 1952	2°46′ N.	155°10′ W.	In	136
Feb. 3, 1953	1°59′ N.	157°31′ W.	In	136
Feb. 1, 1953	1°57′ N.	157°32′ W.	In	135
Feb. 3, 1953	1°59′ N.	157°31′ W.	In	135
Feb. 5, 1953	3°51′ N.	159°26′ W.	In	134
Feb. 3, 1953	1°59′ N.	157°31′ W.	In	133
Feb. 6, 1952	2°42′ N.	155°05′ W.	In	132
Feb. 1, 1953	1°57′ N.	157°32′ W.	In	131
Feb. 3, 1953	1°59′ N.	157°31′ W.	In	131
Feb. 6, 1952	2°42′ N.	155°05′ W.	In	130
Feb. 1, 1953	1°57′ N.	157°32′ W.	In	130
Feb. 3, 1953	1°59′ N.	157°31′ W.	In	130
Feb. 4, 1951	3°52′ N.	159°20′ W.	In	98
Feb. 5, 1953	3°51′ N.	159°26′ W.	Im	123
Feb. 3, 1953	1°59′ N.	157°31′ W.	Im	120
Feb. 11, 1951	0°22′ S.	160°01′ W.	Im	112
Feb. 10, 1951	0°22′ S.	160°01′ W.	Im	110
Feb. 5, 1953	3°51′ N.	159°26′ W.	Im	107
Do	3°51′ N.	159°26′ W.	Im	105
Feb. 3, 1953	1°59′ N.	157°31′ W.	Im	104
Feb. 16, 1951	0°22′ S.	160°01′ W.	Im	9
Feb. 21, 1951	5°53′ N.	162°05′ W.	Im	90
Feb. 11, 1951	0°22′ S.	160°01′ W.	Im	86
Feb. 21, 1951	5°53′ N.	162°05′ W.	Im	85
Feb. 4, 1951	3°52′ N.	159°20′ W.	Im	85
Feb. 21, 1951	5°53′ N.	162°05′ W.	Im	8
Feb. 16, 1951	1°51′ N.	157°20′ W.	Im	75
Feb. 17, 1951	3°52′ N.	159°20′ W.	Im	7
Feb. 19, 1951	3°52′ N.	159°20′ W.	Im	7
Feb. 22, 1951	5°53′ N.	162°05′ W.	Im	7
Feb. 12, 1951	3°52′ N.	159°20′ W.	Im	7
Feb. 13, 1951	1°51′ N.	157°20′ W.	Im	7
Feb. 8, 1950	4°30′ S.	172°10′ W.	M	12
Feb. 5, 1951	3°07′ S.	171°05′ W.	M	10
Feb. 11, 1950	2°50′ S.	171°40′ W.	Im	12
Feb. 10, 1952	3°15′ S.	171°30′ W.	Im	8
Feb. 8, 1950	4°30′ S.	172°10′ W.	Im	7
Feb. 5, 1951	3°07′ S.	171°05′ W.	Im	6
Feb. 18, 1952	0°02′ N.	179°48′ E.	M	14
Do	0°02′ N.	179°48′ E.	M	14
Feb. 20, 1952	2°39′ S.	179°54′ E.	M	14
Feb. 21, 1952	4°03′ S.	179°58′ E.	M	14
Feb. 20, 1952	2°39′ S.	179°54′ E.	M	13
Feb. 21, 1952	4°03′ S.	179°58′ E.	M	13
Feb. 16, 1952	3°00′ N.	180°00′	M	13
Feb. 19, 1952	1°18′ S.	180°00′	M	13
Do	1°18′ S.	180°00′	M	12
Feb. 23, 1952	6°47′ S.	179°59′ W.	In	13
Feb. 24, 1952	8°00′ S.	179°56′ E.	In	13
Mar. 15, 1953	1°00′ N.	140°00′ W.	R	14
Do	1°00′ N.	140°00′ W.	R	14
Mar. 12, 1953	1°51′ S.	140°11′ W.	R	14
Mar. 11, 1953	1°48′ S.	139°59′ W.	M	16
Mar. 15, 1953	1°00′ N.	140°00′ W.	M	15
Mar. 13, 1953	1°00′ S.	140°05′ W.	M	15
Mar. 15, 1953	1°00′ N.	140°00′ W.	M	14
Mar. 18, 1953	4°12′ N.	140°20′ W.	M	14
Mar. 14, 1953	0°09′ N.	139°47′ W.	M	14
Do	0°09′ N.	139°47′ W.	M	14
Mar. 8, 1953	6°16′ S.	141°32′ W.	M	14
Mar. 13, 1953	1°00′ S.	140°05′ W.	M	14
Do	1°00′ S.	140°05′ W.	M	14
Mar. 17, 1953	3°07′ N.	140°07′ W.	M	14
Mar. 16, 1953	2°12′ N.	140°18′ W.	M	14
Mar. 10, 1953	3°25′ S.	140°03′ W.	M	14
Mar. 14, 1953	0°09′ N.	139°47′ W.	M	14
Mar. 16, 1953	2°12′ N.	140°18′ W.	M	14
Mar. 17, 1953	3°07′ N.	140°07′ W.	M	14
Mar. 11, 1953	1°48′ S.	139°59′ W.	M	14
Mar. 13, 1953	1°00′ S.	140°05′ W.	M	14
Mar. 15, 1953	1°00′ N.	140°00′ W.	M	14
Do	1°00′ N.	140°00′ W.	M	14
Mar. 18, 1953	4°12′ N.	140°20′ W.	M	14
Do	4°12′ N.	140°20′ W.	M	14
Mar. 16, 1953	2°12′ N.	140°18′ W.	M	13
Do	2°12′ N.	140°18′ W.	M	13
Mar. 17, 1953	3°07′ N.	140°07′ W.	M	13
Mar. 14, 1953	0°09′ N.	139°47′ W.	M	13
Mar. 8, 1953	6°16′ S.	141°32′ W.	M	13
Mar. 13, 1953	1°00′ S.	140°05′ W.	M	13
Mar. 12, 1953	1°51′ S.	140°11′ W.	M	13
Mar. 17, 1953	3°07′ N.	140°07′ W.	M	13
Mar. 16, 1953	2°12′ N.	140°18′ W.	M	13
Mar. 18, 1953	4°12′ N.	140°20′ W.	In	14
Mar. 4, 1953	13°31′ S.	147°08′ W.	M	14
Do	13°31′ S.	147°08′ W.	Im	7
Mar. 12, 1952	4°10′ N.	168°30′ W.	R	14
Mar. 4, 1952	6°40′ S.	169°03′ W.	M	14
Do	6°40′ S.	169°03′ W.	M	14
Mar. 8, 1952	1°20′ S.	169°00′ W.	M	14
Mar. 5, 1952	5°18′ S.	169°03′ W.	M	14
Mar. 10, 1952	1°20′ N.	169°05′ W.	M	14
Mar. 9, 1952	0°01′ N.	169°04′ W.	M	14
Mar. 8, 1952	1°20′ S.	169°00′ W.	M	14
Mar. 11, 1952	2°50′ N.	169°07′ W.	M	14
Do	2°50′ N.	169°07′ W.	M	13
Mar. 4, 1952	6°40′ S.	169°03′ W.	M	13
Mar. 9, 1952	0°01′ N.	169°04′ W.	M	13
Mar. 7, 1952	2°43′ S.	169°00′ W.	M	13
Mar. 10, 1952	1°20′ N.	169°05′ W.	M	13
Mar. 11, 1952	2°50′ N.	169°07′ W.	In	14
Mar. 6, 1952	4°02′ S.	169°04′ W.	In	12
Apr. 30, 1951	1°51′ N.	157°20′ W.	M	11

ABLE 1.—*Data on 740 yellowfin tuna specimens from the central equatorial Pacific for which maturity determinations were made in the laboratory*—Continued

Date	Position		Stage of maturity	Fish length
	Latitude	Longitude		
				Cm.
pr. 26, 1951	1°51′ N.	157°20′ W.	M	98
pr. 27, 1951	1°51′ N.	157°20′ W.	In	108
Do	1°51′ N.	157°20′ W.	In	96
pr. 30, 1951	1°51′ N.	157°20′ W.	In	96
pr. 26, 1951	1°51′ N.	157°20′ W.	In	81
pr. 18, 1951	5°53′ N.	162°05′ W.	Im	110
pr. 16, 1951	5°53′ N.	162°05′ W.	Im	104
pr. 11, 1951	0°22′ S.	160°01′ W.	Im	98
pr. 13, 1951	5°53′ N.	162°05′ W.	Im	98
pr. 16, 1950	5°53′ N.	162°05′ W.	Im	98
pr. 15, 1951	5°53′ N.	162°05′ W.	Im	92
pr. 16, 1951	5°53′ N.	162°05′ W.	Im	90
pr. 24, 1951	1°51′ N.	157°20′ W.	Im	80
pr. 26, 1951	1°51′ N.	157°20′ W.	Im	80
pr. 27, 1951	1°51′ N.	157°20′ W.	Im	80
pr. 26, 1951	1°51′ N.	157°20′ W.	Im	75
pr. 13, 1951	5°53′ N.	162°05′ W.	Im	70
lay 29, 1952	7°09′ N.	119°00′ W.	R	148
lay 31, 1952	4°18′ N.	119°35′ W.	M	146
Do	4°18′ N.	119°35′ W.	M	146
Do	4°18′ N.	119°35′ W.	M	135
lay 23, 1954	4°55′ N.	161°19′ W.	M	151
lay 28, 1954	4°02′ N.	159°34′ W.	M	146
Do	4°02′ N.	159°34′ W.	M	146
Do	4°02′ N.	159°34′ W.	M	143
lay 23, 1954	4°55′ N.	161°19′ W.	M	140
lay 30, 1954	3°58′ N.	159°04′ W.	M	140
lay 7, 1951	3°52′ N.	159°20′ W.	M	136
lay 13, 1950	1°51′ N.	157°20′ W.	M	136
lay 25, 1954	4°45′ N.	160°11′ W.	M	134
lay 23, 1954	4°55′ N.	161°19′ W.	M	133
lay 26, 1954	4°52′ N.	159°35′ W.	M	133
lay 18, 1954	6°02′ N.	162°28′ W.	M	130
lay 22, 1954	5°26′ N.	161°37′ W.	M	129
lay 23, 1954	4°55′ N.	161°19′ W.	M	129
lay 31, 1951	6°25′ N.	162°26′ W.	M	127
lay 24, 1954	4°56′ N.	160°32′ W.	M	123
lay 25, 1954	4°45′ N.	160°11′ W.	M	122
lay 27, 1954	4°17′ N.	160°28′ W.	M	121
lay 28, 1954	4°02′ N.	159°34′ W.	M	117
lay 27, 1954	4°17′ N.	160°28′ W.	M	114
lay 31, 1951	6°25′ N.	162°26′ W.	M	106
Do	6°25′ N.	162°26′ W.	M	101
Do	6°25′ N.	162°26′ W.	M	100
Do	6°25′ N.	162°26′ W.	M	92
Do	6°25′ N.	126°26′ W.	M	92
lay 1, 1951	1°51′ N.	157°20′ W.	M	86
lay 26, 1954	4°52′ N.	159°35′ W.	In	128
lay 28, 1954	4°02′ N.	159°34′ W.	In	122
lay 25, 1954	4°45′ N.	160°11′ W.	In	121
lay 28, 1950	5°53′ N.	162°05′ W.	In	118
lay 30, 1954	3°58′ N.	159°04′ W.	In	117
lay 3, 1950	4°42′ N.	160°24′ W.	In	115
lay 31, 1950	6°25′ N.	162°26′ W.	In	115
lay 30, 1954	3°58′ N.	159°04′ W.	In	114
lay 27, 1954	4°17′ N.	160°28′ W.	In	110
lay 29, 1950	6°25′ N.	162°26′ W.	In	109
lay 30, 1954	3°58′ N.	159°04′ W.	In	108
lay 12, 1950	1°51′ N.	157°20′ W.	In	107
lay 17, 1954	5°58′ N.	162°52′ W.	In	106
lay 11, 1951	5°53′ N.	162°05′ W.	In	104
lay 30, 1954	3°58′ N.	159°04′ W.	In	104
lay 1, 1951	1°51′ N.	157°20′ W.	In	100
lay 31, 1951	6°25′ N.	162°26′ W.	In	100
lay 1, 1951	1°51′ N.	157°20′ W.	In	98
lay 30, 1954	3°58′ N.	159°04′ W.	In	98
lay 30, 1951	6°25′ N.	162°26′ W.	In	94
lay 12, 1951	6°25′ N.	162°26′ W.	In	92
lay 30, 1951	6°25′ N.	162°26′ W.	In	90
lay 31, 1951	6°25′ N.	162°26′ W.	In	90
lay 30, 1951	6°25′ N.	162°26′ W.	In	89
lay 31, 1951	6°25′ N.	162°26′ W.	In	88
Do	6°25′ N.	162°26′ W.	In	88
Do	6°25′ N.	162°26′ W.	In	88
lay 28, 1950	6°25′ N.	162°26′ W.	In	85
lay 31, 1951	6°25′ N.	162°26′ W.	In	82
lay 17, 1954	5°58′ N.	162°52′ W.	Im	149
lay 31, 1950	6°25′ N.	162°26′ W.	Im	115
lay 27, 1950	5°53′ N.	162°05′ W.	Im	112
lay 3, 1950	4°42′ N.	160°24′ W.	Im	111
lay 17, 1954	5°58′ N.	162°52′ W.	Im	111
lay 3, 1950	4°42′ N.	160°24′ W.	Im	108
Do	4°42′ N.	160°24′ W.	Im	104
lay 30, 1954	3°58′ N.	159°04′ W.	Im	103
lay 28, 1954	4°02′ N.	159°34′ W.	Im	102
lay 17, 1954	5°58′ N.	162°52′ W.	Im	101
lay 28, 1954	4°02′ N.	159°34′ W.	Im	101
lay 30, 1954	3°58′ N.	159°04′ W.	Im	101
lay 17, 1954	5°58′ N.	162°52′ W.	Im	100
lay 30, 1951	6°25′ N.	162°26′ W.	Im	96

Date	Position		Stage of maturity	Fish length
	Latitude	Longitude		
				Cm.
May 28, 1954	4°02′ N.	159°34′ W.	Im	93
May 30, 1951	6°25′ N.	162°26′ W.	Im	90
May 20, 1951	6°25′ N.	162°26′ W.	Im	88
May 24, 1954	4°56′ N.	160°32′ W.	Im	88
May 30, 1951	6°25′ N.	162°26′ W.	Im	88
Do	6°25′ N.	162°26′ W.	Im	87
Do	6°25′ N.	162°26′ W.	Im	86
Do	6°25′ N.	162°26′ W.	Im	86
May 31, 1951	6°25′ N.	162°26′ W.	Im	85
May 1, 1951	1°51′ N.	157°20′ W.	Im	83
Do	1°51′ N.	157°20′ W.	Im	82
Do	1°51′ N.	157°20′ W.	Im	81
Do	1°51′ N.	157°20′ W.	Im	80
Do	1°51′ N.	157°20′ W.	Im	80
May 7, 1951	3°52′ N.	159°20′ W.	Im	79
May 3, 1950	4°42′ N.	160°24′ W.	Im	75
May 11, 1951	6°25′ N.	162°26′ W.	Im	75
Do	6°25′ N.	162°26′ W.	Im	75
May 27, 1950	5°53′ N.	162°05′ W.	Im	74
Do	6°25′ N.	162°26′ W.	Im	74
May 30, 1953	4°26′ S.	170°09′ W.	R	134
May 31, 1953	3°27′ S.	170°12′ W.	M	149
May 28, 1953	6°51′ S.	170°02′ W.	M	148
May 30, 1953	4°26′ S.	170°09′ W.	M	144
Do	4°26′ S.	170°09′ W.	M	136
Do	4°26′ S.	170°09′ W.	M	136
Do	4°26′ S.	170°09′ W.	M	133
May 29, 1953	5°41′ S.	169°44′ W.	M	103
May 30, 1953	4°26′ S.	170°09′ W.	In	130
Do	4°26′ S.	170°09′ W.	Im	94
June 3, 1952	0°19′ N.	119°58′ W.	M	157
June 12, 1952	6°06′ N.	129°55′ W.	R	156
June 9, 1952	2°19′ N.	130°07′ W.	R	150
June 12, 1952	6°06′ N.	129°55′ W.	R	142
June 13, 1952	8°00′ N.	130°24′ W.	R	139
June 12, 1952	6°06′ N.	129°55′ W.	R	129
June 13, 1952	8°00′ N.	130°24′ W.	R	94
June 6, 1952	1°01′ S.	125°56′ W.	M	153
June 8, 1952	0°21′ N.	129°23′ W.	M	153
June 9, 1952	2°19′ N.	130°07′ W.	M	146
Do	2°19′ N.	130°07′ W.	M	135
Do	2°19′ N.	130°07′ W.	Im	142
June 1, 1951	6°25′ N.	162°26′ W.	R	90
June 7, 1954	1°52′ N.	156°47′ W.	M	152
June 2, 1954	2°29′ N.	158°22′ W.	M	147
June 1, 1954	3°04′ N.	159°13′ W.	M	146
June 9, 1954	1°47′ N.	158°16′ W.	M	142
June 1, 1954	3°04′ N.	159°13′ W.	M	140
June 2, 1954	2°29′ N.	158°22′ W.	M	138
June 7, 1954	1°52′ N.	156°47′ W.	M	126
June 1, 1951	6°25′ N.	162°26′ W.	M	118
June 5, 1950	4°42′ N.	160°24′ W.	M	99
June 1, 1951	6°25′ N.	162°26′ W.	M	90
Do	5°53′ N.	162°05′ W.	M	87
Do	5°53′ N.	162°05′ W.	M	84
Do	5°53′ N.	162°05′ W.	M	83
June 9, 1954	1°47′ N.	158°16′ W.	In	128
June 1, 1954	3°04′ N.	159°13′ W.	In	118
June 7, 1954	1°52′ N.	156°47′ W.	In	115
June 4, 1954	2°03′ N.	157°40′ W.	In	114
Do	2°03′ N.	157°40′ W.	In	112
June 1, 1954	3°04′ N.	159°13′ W.	In	110
June 4, 1950	4°42′ N.	160°24′ W.	In	110
June 8, 1954	2°01′ N.	157°09′ W.	In	108
June 4, 1954	2°03′ N.	157°40′ W.	In	100
June 8, 1954	2°01′ N.	157°09′ W.	Im	120
June 7, 1954	1°52′ N.	156°47′ W.	Im	110
June 4, 1950	4°42′ N.	160°24′ W.	Im	100
June 8, 1954	2°01′ N.	157°09′ W.	Im	94
June 6, 1951	3°52′ N.	159°20′ W.	Im	85
Do	3°52′ N.	159°20′ W.	Im	83
Do	3°52′ N.	159°20′ W.	Im	83
June 4, 1950	4°42′ N.	160°24′ W.	Im	82
June 6, 1951	3°52′ N.	159°20′ W.	Im	82
Do	3°52′ N.	159°20′ W.	Im	82
Do	3°52′ N.	159°20′ W.	Im	80
June 1, 1951	5°53′ N.	162°05′ W.	Im	77
Do	5°53′ N.	162°05′ W.	Im	76
Do	5°53′ N.	162°05′ W.	Im	76
June 3, 1950	5°53′ N.	162°05′ W.	Im	75
June 2, 1953	0°30′ S.	169°52′ W.	R	138
June 1, 1953	2°14′ S.	170°00′ W.	M	142
June 2, 1953	0°30′ S.	169°52′ W.	M	141
Do	0°30′ S.	169°52′ W.	M	133
Do	0°30′ S.	169°52′ W.	M	131
June 1, 1953	2°14′ S.	170°00′ W.	M	129
June 2, 1953	0°30′ S.	169°52′ W.	M	121
June 1, 1953	2°14′ S.	170°00′ W.	M	102
June 12, 1951	2°50′ S.	171°40′ W.	Im	135
June 17, 1951	2°50′ S.	171°40′ W.	Im	122

TABLE 1.—*Data on 740 yellowfin tuna specimens from the central equatorial Pacific for which maturity determinations were made in the laboratory*—Continued

Date	Position		Stage of maturity	Fish length
	Latitude	Longitude		
				Cm.
June 17, 1951	2°50′ S.	171°40′ W.	Im	118
June 1, 1953	2°14′ S.	170°00′ W.	Im	81
July 17, 1950	2°50′ S.	171°40′ W.	M	140
July 15, 1950	2°50′ S.	171°40′ W.	M	128
July 19, 1950	2°50′ S.	171°40′ W.	In	134
Do	2°50′ S.	171°40′ W.	Im	118
Aug. 24, 1952	4°28′ N.	139°51′ W.	M	156
Aug. 23, 1952	5°16′ N.	140°28′ W.	M	151
Aug. 24, 1952	4°28′ N.	139°51′ W.	M	151
Aug. 31, 1952	3°45′ N.	140°10′ W.	M	151
Aug. 26, 1952	2°23′ N.	140°12′ W.	M	146
Aug. 31, 1952	3°45′ N.	140°10′ W.	M	143
Aug. 28, 1952	1°00′ N.	140°22′ W.	M	139
Aug. 24, 1952	4°28′ N.	139°51′ W.	M	129
Aug. 21, 1952	7°02′ N.	140°46′ W.	M	124
Aug. 23, 1952	5°16′ N.	140°28′ W.	M	121
Aug. 28, 1952	1°00′ N.	140°22′ W.	In	157
Aug. 29, 1952	2°00′ N.	140°40′ W.	In	153 or 139
Aug. 27, 1952	1°33′ N.	140°13′ W.	In	147
Aug. 31, 1952	3°45′ N.	140°10′ W.	In	142
Aug. 26, 1952	2°23′ N.	140°12′ W.	In	141
Aug. 29, 1952	2°00′ N.	140°40′ W.	In	139
Aug. 13, 1953	0°08′ N.	154°51′ W.	M	168
Do	0°08′ N.	154°51′ W.	M	143
Do	0°08′ N.	154°51′ W.	M	143
Aug. 27, 1951	9°36′ N.	150°06′ W.	M	143 or 131
Aug. 13, 1953	0°08′ N.	154°51′ W.	M	142
Do	0°08′ N.	154°51′ W.	M	141
Do	0°08′ N.	154°51′ W.	M	138
Aug. 26, 1953	7°50′ N.	159°24′ W.	M	153
Aug. 16, 1953	4°10′ S.	155°33′ W.	M	151
Aug. 12, 1953	1°21′ N.	155°16′ W.	M	148
Aug. 19, 1953	1°31′ S.	159°53′ W.	M	144
Aug. 7, 1953	2°05′ N.	157°38′ W.	M	143
Do	2°05′ N.	157°38′ W.	M	142
Aug. 21, 1953	1°11′ N.	160°08′ W.	M	142
Aug. 25, 1953	6°10′ N.	160°02′ W.	M	142
Aug. 7, 1953	2°05′ N.	157°38′ W.	M	141
Aug. 20, 1953	0°01′ N.	159°56′ W.	M	141
Aug. 21, 1953	1°11′ N.	160°08′ W.	M	141
Do	1°11′ N.	160°08′ W.	M	141
Do	1°11′ N.	160°08′ W.	M	140
Do	1°11′ N.	160°08′ W.	M	140
Aug. 19, 1953	1°31′ S.	159°53′ W.	M	139
Aug. 25, 1953	6°10′ N.	160°02′ W.	M	139
Aug. 7, 1953	2°05′ N.	157°38′ W.	M	138
Aug. 12, 1953	1°21′ N.	155°16′ W.	M	136
Do	1°21′ N.	155°16′ W.	M	136
Aug. 19, 1953	1°31′ S.	159°53′ W.	M	136
Aug. 20, 1953	0°01′ N.	159°56′ W.	M	136
Aug. 7, 1953	2°05′ N.	157°38′ W.	M	135
Do	2°05′ N.	157°38′ W.	M	135
Aug. 12, 1953	1°21′ N.	155°16′ W.	M	135
Aug. 14, 1953	1°08′ S.	155°18′ W.	M	134
Aug. 19, 1953	1°31′ S.	159°53′ W.	M	134
Aug. 23, 1953	3°22′ N.	160°24′ W.	M	128
Aug. 7, 1953	2°05′ N.	157°38′ W.	M	126
Do	2°05′ N.	157°38′ W.	M	124
Aug. 25, 1950	6°25′ N.	162°26′ W.	M	111
Aug. 14, 1953	1°08′ S.	155°18′ W.	In	147
Aug. 19, 1953	1°31′ S.	159°53′ W.	In	142
Aug. 14, 1953	1°08′ S.	155°18′ W.	In	140
Aug. 16, 1953	4°10′ S.	155°33′ W.	In	139
Aug. 14, 1953	1°08′ S.	155°18′ W.	In	138
Aug. 18, 1953	2°56′ S.	160°14′ W.	In	138
Aug. 19, 1953	1°31′ S.	159°53′ W.	In	138
Do	1°31′ S.	159°53′ W.	In	136
Aug. 14, 1953	1°08′ S.	155°18′ W.	In	134
Aug. 18, 1953	2°56′ S.	160°14′ W.	In	132
Aug. 14, 1953	1°08′ S.	155°18′ W.	In	131
Aug. 21, 1953	1°11′ N.	160°08′ W.	In	127
Aug. 19, 1953	1°31′ S.	159°53′ W.	In	125
Aug. 21, 1953	1°11′ N.	160°08′ W.	In	111
Aug. 15, 1953	2°33′ S.	155°23′ W.	In	89
Aug. 18, 1953	2°56′ S.	160°14′ W.	Im	139
Aug. 20, 1953	0°01′ N.	159°56′ W.	Im	116
Aug. 21, 1953	1°11′ N.	160°08′ W.	Im	109
Aug. 14, 1953	1°08′ S.	155°18′ W.	Im	104
Aug. 25, 1953	6°10′ N.	160°02′ W.	Im	102
Aug. 18, 1953	2°56′ S.	160°14′ W.	Im	89
Aug. 16, 1950	3°35′ S.	171°31′ W.	M	118
Do	3°35′ S.	171°31′ W.	Im	114
Aug. 17, 1950	3°07′ S.	171°05′ W.	Im	85
Do	3°07′ S.	171°05′ W.	Im	66
Do	3°07′ S.	171°05′ W.	Im	64
Sept. 6, 1952	2°06′ N.	140°56′ W.	R	155
Sept. 9, 1952	2°33′ N.	143°22′ W.	R	136
Sept. 7, 1952	1°42′ N.	141°24′ W.	M	153
Sept. 9, 1952	2°33′ N.	143°22′ W.	M	148
Do	2°33′ N.	143°22′ W.	M	147
Sept. 3, 1952	4°04′ N.	140°09′ W.	M	14
Sept. 6, 1952	2°06′ N.	140°56′ W.	M	14
Sept. 7, 1952	1°42′ N.	141°24′ W.	M	14
Do	1°42′ N.	141°24′ W.	M	13
Sept. 2, 1952	3°05′ N.	140°02′ W.	In	15
Sept. 6, 1952	2°06′ N.	140°56′ W.	In	14
Sept. 2, 1952	3°05′ N.	140°02′ W.	In	14
Sept. 4, 1952	3°20′ N.	140°10′ W.	In	14
Sept. 7, 1952	1°42′ N.	141°24′ W.	In	14
Sept. 1, 1952	3°31′ N.	140°28′ W.	In	13
Sept. 2, 1952	3°05′ N.	140°02′ W.	In	13
Sept. 4, 1952	3°20′ N.	140°10′ W.	Im	14
Sept. 5, 1951	2°02′ N.	151°50′ W.	R	14
Sept. 13, 1952	1°22′ N.	149°54′ W.	R	13
Sept. 2, 1951	4°04′ N.	150°06′ W.	M	15
Sept. 13, 1952	1°22′ N.	149°54′ W.	M	15
Sept. 16, 1952	2°28′ N.	150°38′ W.	M	15
Sept. 4, 1951	1°59′ N.	150°12′ W.	M	14
Sept. 15, 1952	2°05′ N.	150°23′ W.	M	14
Sept. 19, 1951	2°00′ N.	151°24′ W.	M	14
Sept. 3, 1951	2°57′ N.	150°17′ W.	M	14
Sept. 19, 1951	2°00′ N.	151°24′ W.	M	14
Sept. 3, 1951	2°57′ N.	150°17′ W.	M	14
Sept. 18, 1951	2°02′ N.	153-12′ W.	M	14
Sept. 19, 1951	2°00′ N.	151°24′ W.	M	14
Sept. 20, 1951	0°54′ N.	150°00′ W.	M	14
Sept. 3, 1951	2°57′ N.	150°17′ W.	M	14
Sept. 19, 1951	2°00′ N.	151°24′ W.	M	14
Sept. 3, 1951	2°57′ N.	150°17′ W.	M	14
Do	2°57′ N.	150°17′ W.	M	14
Sept. 4, 1951	1°59′ N.	150°12′ W.	M	14
Sept. 6, 1951	2°03′ N.	153°12′ W.	M	14
Sept. 19, 1951	2°00′ N.	151°24′ W.	M	14
Sept. 4, 1951	1°59′ N.	150°12′ W.	M	14
Do	1°59′ N.	150°12′ W.	M	14
Sept. 17, 1951	2°01′ N.	154°50′ W.	M	14
Sept. 18, 1951	2°02′ N.	153°12′ W.	M	14
Sept. 19, 1951	2°00′ N.	151°24′ W.	M	14
Sept. 2, 1951	4°04′ N.	150°06′ W.	M	14
Sept. 3, 1951	2°57′ N.	150°17′ W.	M	14
Sept. 5, 1951	2°02′ N.	151°50′ W.	M	14
Do	2°02′ N.	151°50′ W.	M	14
Sept. 19, 1951	2°00′ N.	151°24′ W.	M	14
Do	2°00′ N.	151°24′ W.	M	14
Sept. 20, 1951	0°54′ N.	150°00′ W.	M	14
Sept. 2, 1951	4°04′ N.	150°06′ W.	M	14
Sept. 5, 1951	2°02′ N.	151°50′ W.	M	14
Sept. 19, 1951	2°00′ N.	151°24′ W.	M	14
Do	2°00′ N.	151°24′ W.	M	14
Sept. 2, 1951	4°04′ N.	150°06′ W.	M	13
Do	4°04′ N.	150°06′ W.	M	13
Sept. 3, 1951	2°57′ N.	150°17′ W.	M	13
Sept. 19, 1951	2°00′ N.	151°24′ W.	M	13
Do	2°00′ N.	151°24′ W.	M	13
Sept. 20, 1951	0°54′ N.	150°00′ W.	M	13
Sept. 2, 1951	4°04′ N.	150°06′ W.	M	13
Do	4°04′ N.	150°06′ W.	M	13
Sept. 3, 1951	2°57′ N.	150°17′ W.	M	13
Sept. 5, 1951	2°02′ N.	151°50′ W.	M	13
Sept. 13, 1952	1°22′ N.	149°54′ W.	M	13
Sept. 17, 1951	2°01′ N.	154°50′ W.	M	13
Sept. 19, 1951	2°00′ N.	151°24′ W.	M	13
Sept. 20, 1951	0°54′ N.	150°00′ W.	M	13
Sept. 4, 1951	1°59′ N.	150°12′ W.	M	13
Sept. 6, 1951	2°03′ N.	153°12′ W.	M	13
Do	2°03′ N.	153°12′ W.	M	13
Sept. 18, 1951	2°02′ N.	153°12′ W.	M	13
Sept. 2, 1951	4°04′ N.	150°06′ W.	M	13
Do	4°04′ N.	150°06′ W.	M	13
Sept. 5, 1951	2°02′ N.	151°50′ W.	M	13
Sept. 16, 1952	2°28′ N.	150°38′ W.	M	13
Sept. 2, 1951	4°04′ N.	150°06′ W.	M	13
Sept. 3, 1951	2°57′ N.	150°17′ W.	M	13
Sept. 18, 1951	2°02′ N.	153°12′ W.	M	13
Sept. 3, 1951	2°57′ N.	150°17′ W.	M	13
Sept. 5, 1951	2°02′ N.	151°50′ W.	M	13
Do	2°02′ N.	151°50′ W.	M	13
Sept. 3, 1951	2°57′ N.	150°17′ W.	M	13
Sept. 4, 1951	1°59′ N.	150°12′ W.	M	13
Sept. 5, 1951	2°02′ N.	151°50′ W.	M	13
Sept. 6, 1951	2°03′ N.	153°12′ W.	M	13
Sept. 2, 1951	4°04′ N.	150°06′ W.	M	12
Sept. 17, 1952	3°26′ N.	151°40′ W.	M	12
Sept. 4, 1951	1°59′ N.	150°12′ W.	M	12
Sept. 3, 1951	2°57′ N.	150°17′ W.	M	11
Sept. 18, 1951	2°02′ N.	153°12′ W.	M	10
Sept. 17, 1951	2°01′ N.	154°50′ W.	M	7
Sept. 19, 1951	2°00′ N.	151°24′ W.	In	14
Sept. 17, 1951	2°01′ N.	154°50′ W.	In	14
Sept. 19, 1951	2°00′ N.	151°24′ W.	In	14

ABLE 1.—*Data on 740 yellowfin tuna specimens from the central equatorial Pacific for which maturity determinations were made in the laboratory*—Continued

Date	Position		Stage of maturity	Fish length
	Latitude	Longitude		
				Cm.
ot. 22, 1951	1°07′ S.	150°21′ W.	In	142
ot. 17, 1951	2°01′ N.	154°50′ W.	In	141
Do	2°01′ N.	154°50′ W.	In	141
Do	2°01′ N.	154°50′ W.	In	140
Do	2°01′ N.	154°50′ W.	In	140
ot. 19, 1951	2°00′ N.	151°24′ W.	In	140
ot. 17, 1951	2°01′ N.	154°50′ W.	In	139
Do	2°01′ N.	154°50′ W.	In	139
ot. 20, 1951	0°54′ N.	150°00′ W.	In	139
ot. 19, 1951	2°00′ N.	151°24′ W.	In	138
ot. 17, 1951	2°01′ N.	154°50′ W.	In	137
ot. 4, 1951	1°59′ N.	150°12′ W.	In	136
ot. 17, 1951	2°01′ N.	154°50′ W.	In	134
ot. 25, 1951	4°56′ S.	150°13′ W.	In	133
ot. 17, 1951	2°01′ N.	154°50′ W.	In	131
Do	2°01′ N.	154°50′ W.	In	131
ot. 18, 1951	2°02′ N.	153°12′ W.	In	129
ot. 17, 1951	2°01′ N.	154°50′ W.	In	128
ot. 2, 1951	4°04′ N.	150°06′ W.	In	127
ot. 25, 1951	4°56′ S.	150°13′ W.	In	122
Do	4°56′ S.	150°13′ W.	Im	117
ot. 12, 1951	1°52′ N.	155°24′ W.	M	144
ot. 15, 1951	1°19′ N.	157°30′ W.	M	143
ot. 12, 1951	1°52′ N.	155°24′ W.	M	138
Do	1°52′ N.	155°24′ W.	M	137
ot. 16, 1951	1°52′ N.	156°24′ W.	M	133
ot. 14, 1951	1°59′ N.	157°36′ W.	M	113
ot. 12, 1951	1°52′ N.	155°24′ W.	In	144
ot. 13, 1951	2°02′ N.	156°20′ W.	In	144
Do	2°02′ N.	156°20′ W.	In	144
ot. 12, 1951	1°52′ N.	155°24′ W.	In	142
ot. 13, 1951	2°02′ N.	156°20′ W.	In	141
ot. 16, 1951	1°52′ N.	156°24′ W.	In	140
ot. 13, 1951	2°02′ N.	156°20′ W.	In	136
Do	2°02′ N.	156°20′ W.	In	136
Do	2°02′ N.	156°20′ W.	In	136
ot. 16, 1951	1°52′ N.	156°24′ W.	In	136
ot. 13, 1951	2°02′ N.	156°20′ W.	In	135
ot. 12, 1951	1°52′ N.	155°24′ W.	In	133
ot. 15, 1951	1°19′ N.	157°30′ W.	In	124
ot. 13, 1951	2°02′ N.	156°20′ W.	In	115
ot. 14, 1951	1°59′ N.	157°36′ W.	In	114
Do	1°59′ N.	157°36′ W.	In	109
Do	1°59′ N.	157°36′ W.	In	93
Do	1°59′ N.	157°36′ W.	Im	104
Do	1°59′ N.	157°36′ W.	Im	96
t. 19, 1952	8°14′ N.	120°32′ W.	R	147
t. 30, 1952	3°58′ S.	120°14′ W.	In	133
t. 31, 1952	5°36′ S.	120°25′ W.	Im	159
t. 27, 1952	5°34′ N.	152°26′ W.	M	143
t. 29, 1952	3°12′ N.	152°05′ W.	M	135
t. 27, 1952	5°34′ N.	152°26′ W.	M	127
t. 30, 1952	2°15′ N.	151°19′ W.	In	149
t. 27, 1952	5°34′ N.	152°26′ W.	In	140
t. 30, 1952	2°15′ N.	151°19′ W.	In	137
t. 27, 1952	5°34′ N.	152°26′ W.	In	135
t. 28, 1952	4°00′ N.	152°20′ W.	In	133
t. 25, 1950	7°17′ N.	157°04′ W.	M	143
t. 31, 1950	6°25′ N.	162°26′ W.	Im	99
Do	6°25′ N.	162°26′ W.	Im	95
Do	6°25′ N.	162°26′ W.	Im	95
Do	6°25′ N.	162°26′ W.	Im	88
v. 1, 1952	7°33′ S.	120°21′ W.	M	138
Do	7°33′ S.	120°21′ W.	In	139
Do	7°33′ S.	120°21′ W.	In	127
Do	7°33′ S.	120°21′ W.	In	123
Do	7°33′ S.	120°21′ W.	Im	153
v. 6, 1952	3°11′ S.	130°17′ W.	M	132
Do	3°11′ S.	130°17′ W.	Im	150
v. 3, 1952	1°00′ N.	151°26′ W.	In	[1] 145
Do	1°00′ N.	151°26′ W.	In	142
v. 2, 1952	2°13′ N.	151°51′ W.	In	135
v. 6, 1950	5°53′ N.	162°05′ W.	M	146
v. 7, 1950	6°13′ N.	163°05′ W.	M	134
v. 8, 1950	6°59′ N.	163°54′ W.	M	133
v. 9, 1950	7°24′ N.	164°23′ W.	M	133
v. 30, 1950	6°25′ N.	162°26′ W.	M	129
v. 9, 1950	7°24′ N.	164°23′ W.	In	143
v. 16, 1950	3°52′ N.	159°20′ W.	In	143
v. 24, 1950	6°13′ N.	158°53′ W.	In	140
v. 19, 1950	1°12′ N.	160°21′ W.	In	139
v. 1, 1950	1°51′ N.	157°20′ W.	In	136
v. 21, 1950	3°52′ N.	159°57′ W.	In	134
Do	3°52′ N.	159°57′ W.	In	132
v. 24, 1950	6°13′ N.	158°53′ W.	In	122
v. 20, 1950	2°55′ N.	160°20′ W.	Im	143
Do	2°55′ N.	160°20′ W.	Im	141
v. 19, 1950	1°12′ N.	160°21′ W.	Im	138
Nov. 20, 1950	2°55′ N.	160°20′ W.	Im	137
Nov. 23, 1950	5°04′ N.	159°03′ W.	Im	137
Nov. 21, 1950	3°52′ N.	159°57′ W.	Im	136
Do	3°52′ N.	159°57′ W.	Im	135
Nov. 23, 1950	5°04′ N.	159°03′ W.	Im	135
Nov. 16, 1950	3°52′ N.	159°20′ W.	Im	130
Do	3°52′ N.	159°20′ W.	Im	130
Do	3°52′ N.	159°20′ W.	Im	122
Nov. 24, 1950	6°13′ N.	158°53′ W.	Im	122
Nov. 6, 1950	5°53′ N.	162°05′ W.	Im	120
Nov. 16, 1950	3°52′ N.	159°20′ W.	Im	120
Nov. 23, 1950	4°42′ N.	160°24′ W.	Im	120
Nov. 24, 1950	6°13′ N.	158°53′ W.	Im	118
Nov. 23, 1950	4°42′ N.	160°24′ W.	Im	114
Nov. 3, 1950	6°25′ N.	162°26′ W.	Im	110
Nov. 28, 1950	5°53′ N.	162°05′ W.	Im	110
Nov. 23, 1950	4°42′ N.	160°24′ W.	Im	107
Nov. 2, 1950	4°42′ N.	160°24′ W.	Im	105
Nov. 16, 1950	3°54′ N.	159°26′ W.	Im	104
Nov. 24, 1950	4°42′ N.	160°24′ W.	Im	103
Nov. 2, 1950	4°42′ N.	160°24′ W.	Im	102
Nov. 6, 1950	5°53′ N.	162°05′ W.	Im	101
Nov. 22, 1950	4°42′ N.	160°24′ W.	Im	101
Do	4°42′ N.	160°24′ W.	Im	99
Nov. 23, 1950	4°42′ N.	160°24′ W.	Im	99
Nov. 24, 1950	4°42′ N.	160°24′ W.	Im	98
Nov. 17, 1950	3°52′ N.	159°20′ W.	Im	96
Nov. 23, 1950	4°42′ N.	160°24′ W.	Im	94
Nov. 27, 1950	5°53′ N.	162°05′ W.	Im	93
Nov. 23, 1950	4°42′ N.	160°24′ W.	Im	92
Nov. 27, 1950	5°53′ N.	162°05′ W.	Im	88
Nov. 24, 1950	4°42′ N.	160°24′ W.	Im	87
Nov. 28, 1950	5°53′ N.	162°05′ W.	Im	86
Nov. 23, 1950	4°42′ N.	160°24′ W.	Im	85
Nov. 24, 1950	4°42′ N.	160°24′ W.	Im	85
Nov. 4, 1950	6°25′ N.	162°26′ W.	Im	83
Nov. 3, 1950	6°25′ N.	162°26′ W.	Im	82
Nov. 22, 1950	4°42′ N.	160°24′ W.	Im	81
Nov. 2, 1950	6°25′ N.	162°26′ W.	Im	78
Nov. 4, 1950	5°53′ N.	162°05′ W.	Im	77
Nov. 22, 1950	4°42′ N.	160°24′ W.	Im	77
Nov. 24, 1950	4°42′ N.	160°24′ W.	Im	76
Do	4°42′ N.	160°24′ W.	Im	71
Nov. 28, 1950	5°53′ N.	162°05′ W.	Im	68
Nov. 4, 1950	6°25′ N.	162°26′ W.	Im	63
Nov. 27, 1950	5°53′ N.	162°05′ W.	Im	63
Nov. 30, 1950	6°25′ N.	162°26′ W.	Im	61
Nov. 20, 1952	3°36′ S.	170°02′ W.	R	142
Nov. 11, 1950	6°25′ N.	167°32′ W.	M	153
Nov. 23, 1952	1°00′ S.	169°27′ W.	M	135
Nov. 24, 1952	0°04′ N.	168°48′ W.	M	132
Nov. 26, 1952	2°24′ N.	168°44′ W.	In	139
Nov. 19, 1952	5°00′ S.	170°08′ W.	In	131
Dec. 12, 1953	4°14′ N.	154°56′ W.	In	126
Do	4°14′ N.	154°56′ W.	Im	114
Do	4°14′ N.	154°56′ W.	Im	114
Do	4°14′ N.	154°56′ W.	Im	103
Dec. 6, 1953	2°27′ N.	155°26′ W.	In	148
Dec. 11, 1953	3°31′ N.	155°23′ W.	In	147
Dec. 7, 1953	1°59′ N.	156°09′ W.	In	146
Dec. 3, 1953	1°28′ S.	155°25′ W.	In	144
Do	1°28′ S.	155°25′ W.	In	142
Dec. 8, 1953	2°14′ N.	157°08′ W.	In	140
Dec. 2, 1953	3°02′ S.	155°12′ W.	In	138
Dec. 5, 1953	1°22′ N.	155°18′ W.	In	137
Dec. 11, 1953	3°31′ N.	155°23′ W.	In	137
Dec. 6, 1953	2°27′ N.	155°26′ W.	In	136
Do	2°27′ N.	155°26′ W.	In	134
Do	2°27′ N.	155°26′ W.	In	127
Dec. 1, 1953	4°33′ S.	155°08′ W.	In	123
Dec. 2, 1953	3°02′ S.	155°12′ W.	In	122
Dec. 7, 1953	1°59′ N.	156°09′ W.	In	118
Dec. 8, 1953	2°14′ N.	157°08′ W.	In	110
Dec. 7, 1953	1°59′ N.	156°09′ W.	In	107
Do	1°59′ N.	156°09′ W.	In	105
Dec. 8, 1953	2°14′ N.	157°08′ W.	In	105
Do	2°14′ N.	157°08′ W.	In	103
Do	2°14′ N.	157°08′ W.	In	103
Dec. 2, 1953	3°02′ S.	155°12′ W.	In	88
Dec. 9, 1953	2°01′ N.	158°15′ W.	In	87
Dec. 3, 1953	1°28′ S.	155°25′ W.	Im	144
Dec. 7, 1953	1°59′ N.	156°09′ W.	Im	144
Dec. 9, 1953	2°01′ N.	158°15′ W.	Im	144
Dec. 11, 1953	3°31′ N.	155°23′ W.	Im	144
Do	3°31′ N.	155°23′ W.	Im	144
Dec. 3, 1953	1°28′ S.	155°25′ W.	Im	142
Do	1°28′ S.	155°25′ W.	Im	141
Dec. 11, 1953	3°31′ N.	155 23′ W.	Im	141

[1] From length-weight relation.

TABLE 1.—*Data on 740 yellowfin tuna specimens from the central equatorial Pacific for which maturity determinations we made in the laboratory*—Continued

Date	Position		Stage of maturity	Fish length	Date	Position		Stage of maturity	Fish length
	Latitude	Longitude				Latitude	Longitude		
				Cm.					*Cm.*
Dec. 7, 1953	1°59′ N.	156°09′ W.	Im	138	Dec. 8, 1953	2°14′ N.	157°08′ W.	Im	
Dec. 11, 1953	3°31′ N.	155°23′ W.	Im	138	Do	2°14′ N.	157°08′ W.	Im	
Do	3°31′ N.	155°23′ W.	Im	137	Do	2°14′ N.	157°08′ W.	Im	
Dec. 7, 1953	1°59′ N.	156°09′ W.	Im	136	Do	2°14′ N.	157°08′ W.	Im	
Dec. 11, 1953	3°31′ N.	155°23′ W.	Im	129	Dec. 9, 1953	2°01′ N.	158°15′ W.	Im	
Dec. 1, 1953	4°33′ S.	155°08′ W.	Im	125	Dec. 8, 1953	2°14′ N.	157°08′ W.	Im	
Dec. 5, 1953	1°22′ N.	155°18′ W.	Im	123	Do	2°14′ N.	157°08′ W.	Im	
Dec. 2, 1953	3°02′ S.	155°12′ W.	Im	121	Do	2°14′ N.	157°08′ W.	Im	
Dec. 7, 1953	1°59′ N.	156°09′ W.	Im	120	Do	2°14′ N.	157°08′ W.	Im	
Dec. 2, 1953	3°02′ S.	155°12′ W.	Im	119	Do	2°14′ N.	157°08′ W.	Im	
Dec. 6, 1953	2°27′ N.	155°26′ W.	Im	119	Do	2°14′ N.	157°08′ W.	Im	
Do	2°27′ N.	155°26′ W.	Im	116	Do	2°14′ N.	157°08′ W.	Im	
Dec. 2, 1953	3°02′ S.	155°12′ W.	Im	115	Do	2°14′ N.	157°08′ W.	Im	
Dec. 7, 1953	1°59′ N.	156°09′ W.	Im	110	Dec. 9, 1953	2°01′ N.	158°15′ W.	Im	
Dec. 8, 1953	2°14′ N.	157°08′ W.	Im	110	Dec. 8, 1953	2°14′ N.	157°08′ W.	Im	

On several cruises, observations were made on the state of maturity of ovaries which, with a few exceptions, were then discarded. Although these field observations were subjective and liable to differences between observers, they were used to supplement the seasonal and areal coverage. After discussion with the various observers, and after comparisons of field observations with labo atory classifications, we were able to classify ma of the ovaries reliably into two groups, "inactiv (immature and intermediate) and "active" (m turing and ripe). Field classifications are given table 2. Questionable observations were n considered, and are not included in the table.

TABLE 2.—*Data on yellowfin tuna specimens from the central equatorial Pacific for which maturity determinations were ma in the field*

[A, active; I, inactive]

Date	Position		Stage of maturity	Fish length	Date	Position		Stage of maturity	Fish length
	Latitude	Longitude				Latitude	Longitude		
				Cm.					*Cm*
May 28, 1954	4°02′ N.	159°34′ W.	A	149	June 11, 1954	0°26′ S.	158°57′ W.	A	
May 30, 1954	3°58′ N.	159°04′ W.	A	140	June 14, 1954	0°13′ S.	160°02′ W.	A	
May 28, 1954	4°02′ N.	159°34′ W.	A	139	June 15, 1954	0°30′ S.	160°19′ W.	A	
Do	4°02′ N.	159°34′ W.	A	123	June 3, 1954	1°43′ N.	158°28′ W.	A	
May 17, 1954	5°58′ N.	162°52′ W.	A	120	June 7, 1954	1°52′ N.	156°47′ W.	A	
May 27, 1954	4°17′ N.	160°28′ W.	A	118	June 15, 1954	0°30′ S.	160°19′ W.	A	
May 28, 1954	4°02′ N.	159°34′ W.	A	114	Do	0°30′ S.	160°19′ W.	A	
Do	4°02′ N.	159°34′ W.	I	118	June 11, 1954	0°26′ S.	158°57′ W.	A	
Do	4°02′ N.	159°34′ W.	I	116	June 14, 1954	0°13′ S.	160°02′ W.	A	
Do	4°02′ N.	159°34′ W.	I	114	June 10, 1954	0°50′ N.	158°53′ W.	A	
Do	4°02′ N.	159°34′ W.	I	109	June 15, 1954	0°30′ S.	160°19′ W.	A	
May 30, 1954	3°58′ N.	159°04′ W.	I	108	Do	0°30′ S.	160°19′ W.	A	
May 25, 1954	4°45′ N.	160°11′ W.	I	106	June 13, 1954	0°18′ S.	160°16′ W.	A	
May 28, 1954	4°02′ N.	159°34′ W.	I	106	June 14, 1954	0°13′ S.	160°02′ W.	A	
Do	4°02′ N.	159°34′ W.	I	103	June 12, 1954	0°14′ S.	160°00′ W.	A	
Do	4°02′ N.	159°34′ W.	I	102	June 13, 1954	0°18′ S.	160°16′ W.	A	
May 27, 1954	4°17′ N.	160°28′ W.	I	101	June 14, 1954	0°13′ S.	160°02′ W.	A	
May 30, 1954	3°58′ N.	159°04′ W.	I	100	June 12, 1954	0°14′ S.	160°00′ W.	A	
May 25, 1954	4°45′ N.	160°11′ W.	I	98	June 13, 1954	0°18′ S.	160°16′ W.	A	
May 30, 1954	3°58′ N.	159°04′ W.	I	97	June 10, 1954	0°50′ N.	158°53′ W.	A	
Do	3°58′ N.	159°04′ W.	I	96	June 14, 1954	0°13′ S.	160°02′ W.	A	
Do	3°58′ N.	159°04′ W.	I	93	June 12, 1954	0°14′ S.	160°00′ W.	A	
Do	3°58′ N.	159°04′ W.	I	93	Do	0°14′ S.	160°00′ W.	A	
Do	3°58′ N.	159°04′ W.	I	93	Do	0°14′ S.	160°00′ W.	A	
Do	3°58′ N.	159°04′ W.	I	92	Do	0°14′ S.	160°00′ W.	A	
Do	3°58′ N.	159°04′ W.	I	92	Do	0°14′ S.	160°00′ W.	A	
Do	3°58′ N.	159°04′ W.	I	91	Do	0°14′ S.	160°00′ W.	A	
Do	3°58′ N.	159°04′ W.	I	91	June 8, 1954	2°01′ N.	157°09′ W.	A	
Do	3°58′ N.	159°04′ W.	I	91	June 15, 1954	0°30′ S.	160°19′ W.	A	
Do	3°58′ N.	159°04′ W.	I	89	June 8, 1954	2°01′ N.	157°09′ W.	I	
May 25, 1954	4°45′ N.	160°11′ W.	I	88	June 12, 1954	0°14′ S.	160°00′ W.	I	
May 30, 1954	3°58′ N.	159°04′ W.	I	88	Do	0°14′ S.	160°00′ W.	I	
Do	3°58′ N.	159°04′ W.	I	88	Do	0°14′ S.	160°00′ W.	I	
Do	3°58′ N.	159°04′ W.	I	87	June 13, 1954	0°18′ S.	160°16′ W.	I	
Do	3°58′ N.	159°04′ W.	I	86	June 8, 1954	2°01′ N.	157°09′ W.	I	
May 25, 1954	4°45′ N.	160°11′ W.	I	84	June 12, 1954	0°14′ S.	160°00′ W.	I	
May 30, 1954	3°58′ N.	159°04′ W.	I	83	June 4, 1954	2°03′ N.	157°40′ W.	I	
June 15, 1954	0°30′ S.	160°19′ W.	A	151	June 13, 1954	0°18′ S.	160°16′ W.	I	
June 14, 1954	0°13′ S.	160°02′ W.	A	150	June 4, 1954	2°03′ N.	157°40′ W.	I	
June 15, 1954	0°30′ S.	160°19′ W.	A	150	Do	2°03′ N.	157°40′ W.	I	
June 12, 1954	0°14′ S.	160°00′ W.	A	147	June 8, 1954	2°01′ N.	157°09′ W.	I	

TABLE 2.—*Data on yellowfin tuna specimens from the central equatorial Pacific for which maturity determinations were made in the field*—Continued

Date	Position		Stage of maturity	Fish length
	Latitude	Longitude		
				Cm.
Aug. 25, 1952	3°26′ N.	140°08′ W.	A	142
Aug. 27, 1952	1°33′ N.	140°13′ W.	I	154
Do	1°33′ N.	140°13′ W.	I	152
Do	1°33′ N.	140°13′ W.	I	150
Do	1°33′ N.	140°13′ W.	I	150
Do	1°33′ N.	140°13′ W.	I	149
Aug. 25, 1952	3°26′ N.	140°08′ W.	I	148
Aug. 26, 1952	2°23′ N.	140°12′ W.	I	148
Do	2°23′ N.	140°12′ W.	I	148
Aug. 27, 1952	1°33′ N.	140°13′ W.	I	148
Aug. 28, 1952	1°00′ N.	140°22′ W.	I	148
Aug. 25, 1952	3°26′ N.	140°08′ W.	I	147
Aug. 27, 1952	1°33′ N.	140°13′ W.	I	147
Do	1°33′ N.	140°13′ W.	I	144
Aug. 28, 1952	1°00′ N.	140°22′ W.	I	144
Aug. 26, 1952	2°23′ N.	140°12′ W.	I	142
Aug. 27, 1952	1°33′ N.	140°13′ W.	I	142
Do	1°33′ N.	140°13′ W.	I	141
Do	1°33′ N.	140°13′ W.	I	141
Do	1°33′ N.	140°13′ W.	I	138
Aug. 26, 1952	2°23′ N.	140°12′ W.	I	132
Aug. 24, 1952	4°28′ N.	139°51′ W.	I	131
Aug. 28, 1952	1°00′ N.	140°22′ W.	I	121
Aug. 24, 1952	4°28′ N.	139°51′ W.	I	112
Aug. 27, 1953	9°00′ N.	159°40′ W.	A	147
Aug. 25, 1953	6°10′ N.	160°02′ W.	A	141
Aug. 26, 1953	7°50′ N.	159°24′ W.	A	140
Do	7°50′ N.	159°24′ W.	A	140
Aug. 21, 1953	1°11′ N.	160°08′ W.	A	134
Aug. 22, 1953	2°08′ N.	160°24′ W.	A	128
Aug. 27, 1953	9°00′ N.	159°40′ W.	A	128
Aug. 22, 1953	2°08′ N.	160°24′ W.	A	123
Do	2°08′ N.	160°24′ W.	A	107
Aug. 24, 1953	4°43′ N.	160°00′ W.	I	140
Aug. 22, 1953	2°08′ N.	160°24′ W.	I	125
Aug. 24, 1953	4°43′ N.	160°00′ W.	I	112
Do	4°43′ N.	160°00′ W.	I	111
Aug. 23, 1953	3°22′ N.	160°24′ W.	I	108
Do	3°22′ N.	160°24′ W.	I	104
Do	3°22′ N.	160°24′ W.	I	100
Aug. 24, 1953	4°43′ N.	160°00′ W.	I	99
Do	4°43′ N.	160°00′ W.	I	96
Do	4°43′ N.	160°00′ W.	I	96
Do	4°43′ N.	160°00′ W.	I	95
Do	4°43′ N.	160°00′ W.	I	93
Do	4°43′ N.	160°00′ W.	I	88
Sept. 7, 1952	1°42′ N.	141°24′ W.	I	156
Sept. 3, 1952	4°04′ N.	140°09′ W.	I	150
Sept. 7, 1952	1°42′ N.	141°24′ W.	I	149
Sept. 9, 1952	2°33′ N.	143°22′ W.	I	148
Sept. 2, 1952	3°05′ N.	140°02′ W.	I	147
Do	3°05′ N.	140°02′ W.	I	145
Sept. 5, 1952	2°25′ N.	140°32′ W.	I	145
Sept. 2, 1952	3°05′ N.	140°02′ W.	I	144
Sept. 7, 1952	1°42′ N.	141°24′ W.	I	143
Sept. 9, 1952	2°33′ N.	143°22′ W.	I	143
Sept. 1, 1952	3°31′ N.	140°28′ W.	I	142
Sept. 7, 1952	1°42′ N.	141°24′ W.	I	139
Sept. 5, 1952	2°25′ N.	140°32′ W.	I	136
Sept. 11, 1952	2°57′ N.	147°22′ W.	A	157
Sept. 18, 1952	3°39′ N.	151°54′ W.	A	150
Sept. 16, 1952	2°28′ N.	150°38′ W.	A	146
Sept. 18, 1952	3°39′ N.	151°54′ W.	A	144
Sept. 19, 1952	3°49′ N.	152°10′ W.	A	143
Sept. 15, 1952	2°05′ N.	150°23′ W.	A	142
Sept. 19, 1952	3°49′ N.	152°10′ W.	A	142
Sept. 18, 1952	3°39′ N.	151°54′ W.	A	138
Sept. 16, 1952	2°28′ N.	150°38′ W.	A	137
Sept. 17, 1952	3°26′ N.	151°40′ W.	A	137
Sept. 16, 1952	2°28′ N.	150°38′ W.	A	135
Sept. 11, 1952	2°57′ N.	147°22′ W.	I	148
Sept. 14, 1952	1°48′ N.	150°05′ W.	I	144
Sept. 10, 1952	2°08′ N.	145°21′ W.	I	143
Sept. 11, 1952	2°57′ N.	147°22′ W.	I	143
Sept. 15, 1952	2°05′ N.	150°23′ W.	I	142
Sept. 14, 1952	1°48′ N.	150°05′ W.	I	135
Sept. 10, 1952	2°08′ N.	145°21′ W.	I	134
Sept. 15, 1952	2°05′ N.	150°23′ W.	I	134
Sept. 13, 1952	1°22′ N.	149°54′ W.	I	133
Sept. 16, 1952	2°28′ N.	150°38′ W.	I	117

Additional data (table 3) are available from field observations reported by the Iwate Prefecture Fishery Experiment Station (1953a and 1953b), which were obtained from Japanese longline expeditions into this area. As with the POFI field observations, the stages of maturity were combined into two groups, "active" and "inactive", and the "spent" category was disregarded. Other pertinent information found in these reports is as follows: The fishing area for the April cruise was between latitudes 9° N. and 11° N. and longitudes 170° W. and 173° W. Fish caught on this cruise ranged from 110 to 150 cm. in length, with only one fish measuring less than 120 cm. Fishing during June and July was done at 3° N. to 4° N. and 175° W. to 177° W. Fork lengths ranged from 114 to 173 cm., with only two fish measuring less than 120 cm. Eighty percent of the fish were caught in June, and the rest were caught in July.

TABLE 3.—*Number of yellowfin tuna in various stages of maturity, according to Iwate Prefecture Fishery Experiment Station*

Date	Immature	Maturing	Mature	Ripe	Spent	Location	
						Longitude	Latitude
Apr. 4–24, 1953	3	4	10	14	4	9° N.–11° N.	170° W.–173° W.
June 22–July 3, 1953	29	41	97	26	22	3° N.–4° N.	175° W.–177° W.

Note.—For further data see station reports (1953a and 1953b).

SIZE OF FISH AT FIRST SPAWNING

To determine the size of first-spawning fish, the fork lengths collected by POFI were grouped into classes of 10 cm., and the percentage of fish in the "active" category (maturing and ripe stages), as determined by ovary examination, was calculated for each length class. The results, illustrated in figure 1, show that all the fish smaller than 70 cm. were in a nonspawning condition. In the 70-to-79-cm. class (about 15 to 22 lbs.), 6.9

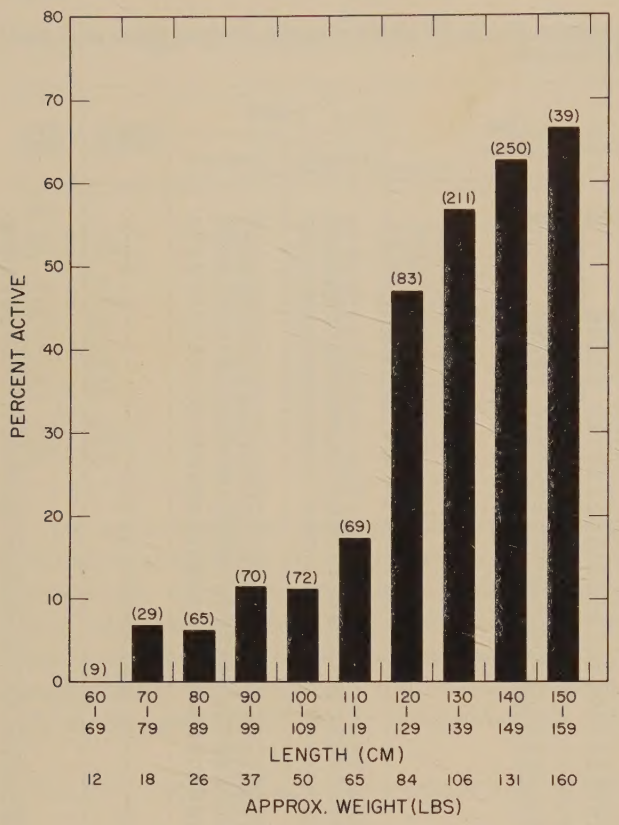

FIGURE 1.—Percentages of sexually active fish at different fork lengths. Figures in parentheses indicate the numbers of individuals on which the percentages are based.

percent were in the maturing or ripe stages. The percentage of sexually active fish increased gradually and irregularly from this length class through the 110-to-119-cm. class (about 57 to 72 lbs.), of which 17.4 percent were active. In the next 10-cm. class (about 74 to 92 lbs.), the percentage of reproductively active fish jumped sharply to 47.0 percent. Above this class the percentage of active fish increased steadily with length. Of the fish measuring 150 to 159 cm. (about 145 to 172 lbs.), 66.7 percent were active.

These data suggest that, although yellowfin as small as 70 cm. are capable of reproducing, the greater part of the population reaches sexual maturity at about 120 cm. Schaefer and Marr (1948), however, noted that in Costa Rican waters yellowfin ranging from 70 to 100 cm. spawn later in the year than the larger fish. This presents the possibility that larger fish have longer spawning periods than smaller fish, which in turn suggests that the smaller percentage of sexually active fish from 70 to 120 cm. in our samples may have resulted from a shorter spawning season rather than from a difference between the proportions of sexually mature fish above 120 cm. and those below 120 cm. Although the representation of fish from 70 to 120 cm. for each month is spotty in our samples, an examination of the monthly percent maturing and ripe (table 4) shows the peak percentage to be far less than that reached by the larger fish. This supports our interpretation of the results, that is, that the greater part of the population reaches sexual maturity at about 120 cm.

TABLE 4.—*Monthly percentages of sexually active yellowfin tuna below 120 cm. fork length*

Month	Fraction active	Percent active
January	1/12	8.3
February	2/26	7.6
March	0/1	0.0
April	2/18	11.0
May	11/101	10.0
June	11/45	24.4
July	0/1	0.0
August	3/24	12.5
September	4/12	33.3
October	0/4	0.0
November	0/31	0.0
December	0/33	0.0

LOCALITY OF SPAWNING

The data were grouped by months and by 10-degree longitudinal sections. The data for those ovaries collected between 115°00′ W. and 124°59′ W. are shown in table 5 in the 120° W. longitudinal section (the midpoint of that section), those collected between 125°00′ and 134°59′ W. in the 130° W. section, and so on, with the exception of the 180° section, which includes 175°00′ W. to 180°. Because the percentage of sexually active fish below 120 cm. was so much smaller, only fish above this size were considered in order to get results that could be used for comparison. The percentage of active fish for each month for each 10-degree section was calculated. The percentages for June and July along 180° were calculated from summarized Japanese data, which did not separate the catch of those 2 months. To arrive at the monthly totals for these months (in the extreme right-hand column of table 5), the 193 fish caught along 180° were separated into 154 fish for June and 39 fish for July, because 80 percent of the catch was made in June.

The results (table 5) show that all the sections had at least one month in which 85 percent or more of the fish were sexually active. This, coupled

TABLE 5.—*Fractions of samples of sexually active yellowfin tuna (maturing and ripe) at various longitudes, by months*

[Percentage of sexually mature fish in sample in parentheses]

Month	At longitude—							Total
	180°	170° W.	160° W.	150° W.	140° W.	130° W.	120° W.	
January			1/6 (16.7%)					1/6 (16.7%)
February	9/11 (81.8%)	1/2 (50.0%)	13/32 (40.6%)	14/30 (46.7%)				37/75 (49.3%)
March		14/16 (87.5%)		1/1 (100.0%)	34/35 (97.1%)			49/52 (94.2%)
April		28/31 (90.3%)						28/31 (90.3%)
May		7/8 (87.5%)	23/27 (85.2%)				4/4 (100.0%)	34/39 (87.2%)
June	131/154 (85.0%)	7/9 (77.8%)	38/43 (88.4%)			9/10 (90.0%)	1/1 (100.0%)	186/217 (85.7%)
July	33/39 (85.0%)	2/3 (66.7%)						35/42 (83.3%)
August			37/53 (69.8%)	7/7 (100.0%)	11/39 (28.2%)			55/99 (55.6%)
September			5/18 (27.8%)	83/115 (72.2%)	22/30 (73.3%)			110/163 (67.5%)
October			1/1 (100.0%)	3/8 (37.5%)			1/3 (33.3%)	5/12 (41.7%)
November		4/6 (66.7%)	5/28 (17.9%)	0/3 (0.0%)		1/2 (50.0%)	1/5 (20.0%)	11/44 (25.0%)
December			0/31 (0.0%)	0/1 (0.0%)				0/32 (0.0%)

with the fact that larvae below 10 mm. have been found in all of these sections (Matsumoto[1]) indicates that yellowfin spawning occurs throughout the central equatorial Pacific. The fact that spawning probably occurs throughout the entire equatorial Pacific is indicated by additional records of spawning yellowfin in the western area by Wade (1950 and 1951), Marr (1948), and Shimada (1951), and in the eastern area by Schaefer and Marr (1948) and Mead (1951).

TIME OF SPAWNING

The percentage of sexually active fish of 120 cm. and longer was calculated for each month of the year and was plotted on a graph (fig. 2). Yellowfin that had almost reached the spawning state were found in each month except December, and the greatest percentages of active fish occurred from March (94.2%) through July (83.3%). It was only during November, December, and January that the occurrence of maturing and ripe fish dropped below 40 percent. This, however, does not prove that spawning is a year-round activity, inasmuch as the length of time that the fish are in these stages before spawning is not known.

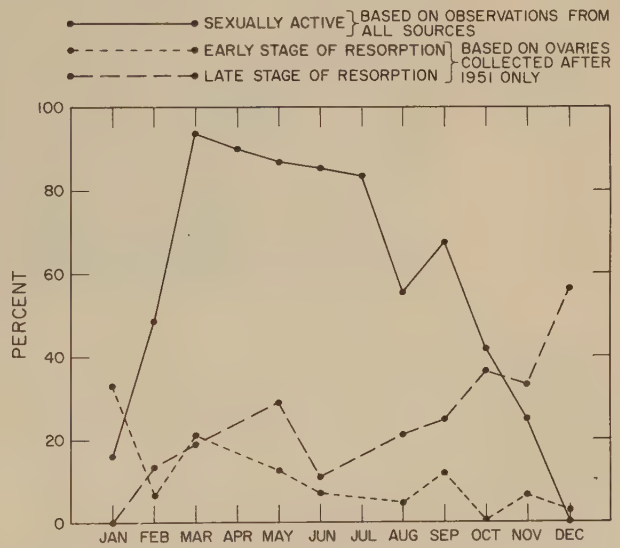

FIGURE 2.— Monthly percentages of yellowfin tuna sexually active or with residual eggs.

To define the spawning season further, the occurrence of residual eggs in these larger fish was investigated with respect to time. The results, plotted in figure 2, show that ovaries with early-

[1] Matsumoto, Walter M.: Descriptions of four species of tuna larvae and their distribution in central Pacific waters. POFI. (Unpublished MS.)

stage residual eggs have the same occurrence pattern as maturing and ripe ovaries. This is true for all the months except January, which is represented by an inadequate sample. The occurrence of these early-stage residual eggs indicates that spawning actually is a year-round occurrence.

Spawning in other equatorial areas of the Pacific likewise seems to be protracted. Schaefer and Marr (1948) found indications of a prolonged spawning season off Costa Rica. Wade (1950) found that the spawning period of yellowfin in the Philippine Islands extended over a considerable period, but that it was most intense during May, June, July, and August. It is probable that the prolonged spawning season is accompanied by multiple spawning—in other words, there is more than one spawning per fish in a spawning season. June (1953) considered this to be true for yellowfin in Hawaiian waters, after studying the progression of modal groups in egg-diameter frequencies.

DESCRIPTION OF STAGES IN RESORPTION OF RESIDUAL EGGS

In the beginning of this study, several structures found in the ovaries could not be readily identified. As more ovaries were examined, it became evident that these structures were the remains of ripe eggs from a previous spawning which were in different stages of resorption. The following descriptions of these stages are based on gross microscopic examination and are intended to aid future workers in recognizing these structures.

Immediately after spawning, these residual eggs (fig. 3) generally resemble the ripe eggs, except that they become shrivelled owing to shrinking of the yolk mass and the resulting collapse of the chorion. The oil sac is usually ruptured, and the released oil appears as bright yellow droplets. The eggs at this stage are still loose and translucent.

Subsequently the eggs lose their translucence and collect in masses of semiopaque tubules. The eggs are not within the tubule but are entangled in the many disordered convolutions of the tubule.

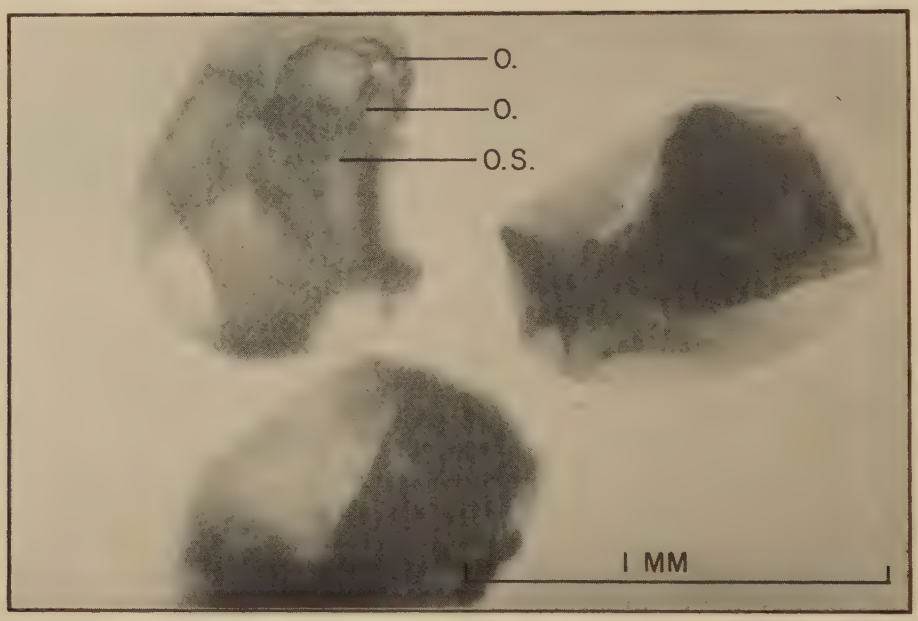

FIGURE 3.—Individual residual eggs; O., oil droplet; O. S., oil sac.

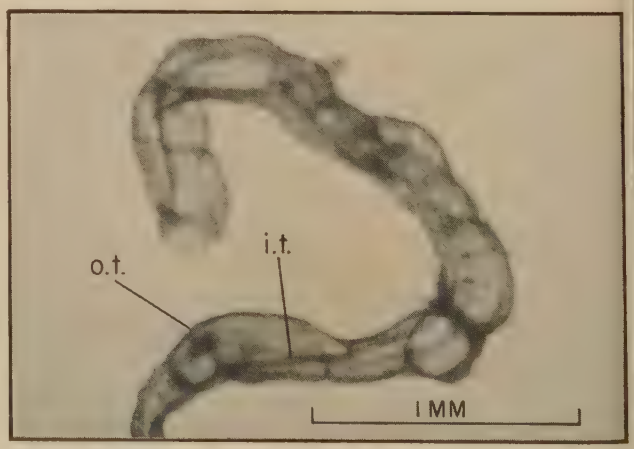

FIGURE 4.—Piece of tubule teased from ovary with residual eggs; i. t., inner tubule; o. t., outer tubule.

The tubular diameter is about 0.20 mm. Within this tubule lies another tubule with a diameter of 0.05 mm. Circular transverse ridges on the wall of the outer tubule give it a striated appearance. Figure 4 shows a short section of a tubule that had been teased from a mass.

Histologically, these masses of tubules and eggs are found to be surrounded by a connective tissue stroma (fig. 5). The wall of the outer tubule seems to be composed of reticular connective tissue. The wall of the inner tubule is made up of a single layer of closely arranged minute cells (3 μ diameter) with relatively large, deep-staining nuclei.

The origin and function of these tubules are open to question, but their proximity to the residual eggs suggests that they are involved in the absorption of these eggs.

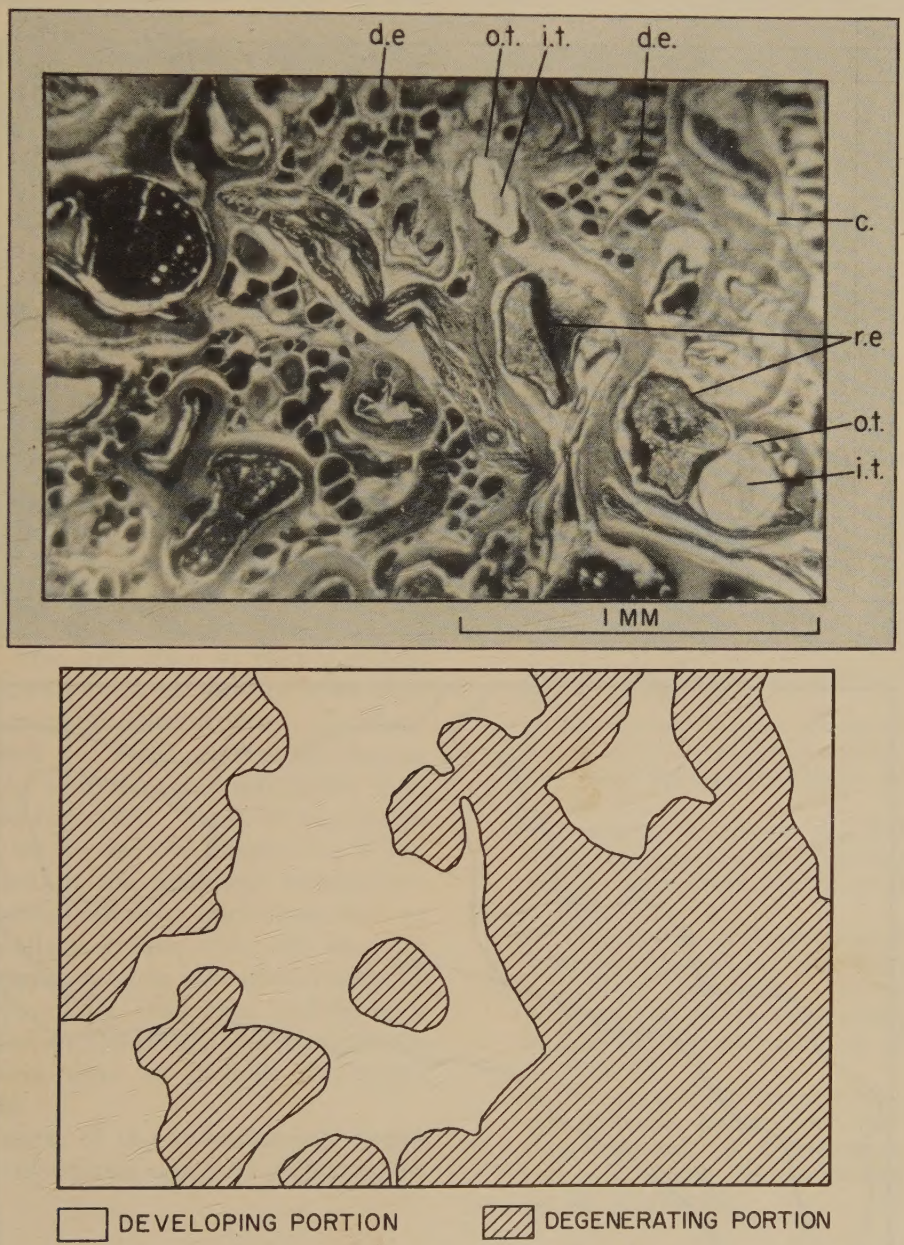

FIGURE 5.—Above: Part of section through ovary showing residual egg mass *in situ*; c., connective tissue capsule; d. e., developing egg; i. t., inner tubule; o. t., outer tubule; r. e., residual egg. Below: Diagram of this section, outlining developing and degenerating portions.

The masses of eggs, tubules, and connective tissue which are scattered throughout the ovary appear to shrink with the passage of time. An examination of later stages shows that the residual eggs are not arranged entirely haphazardly but are lined up to form indistinct cords (fig. 6). These masses eventually shrink to nondescript particles (fig. 7) before they are finally lost in the ovary.

OCCURRENCE OF NEMATODES IN THE OVARIES

While examining the eggs, we observed several ovaries with nematodes, ranging from 0.5 cm. to 4 cm. in length. The specimens were in too poor a state of preservation to identify.

Of 25 ovaries examined for nematodes, 22 (88%) were infested. The extent of infestation did not appear to be serious enough to affect the

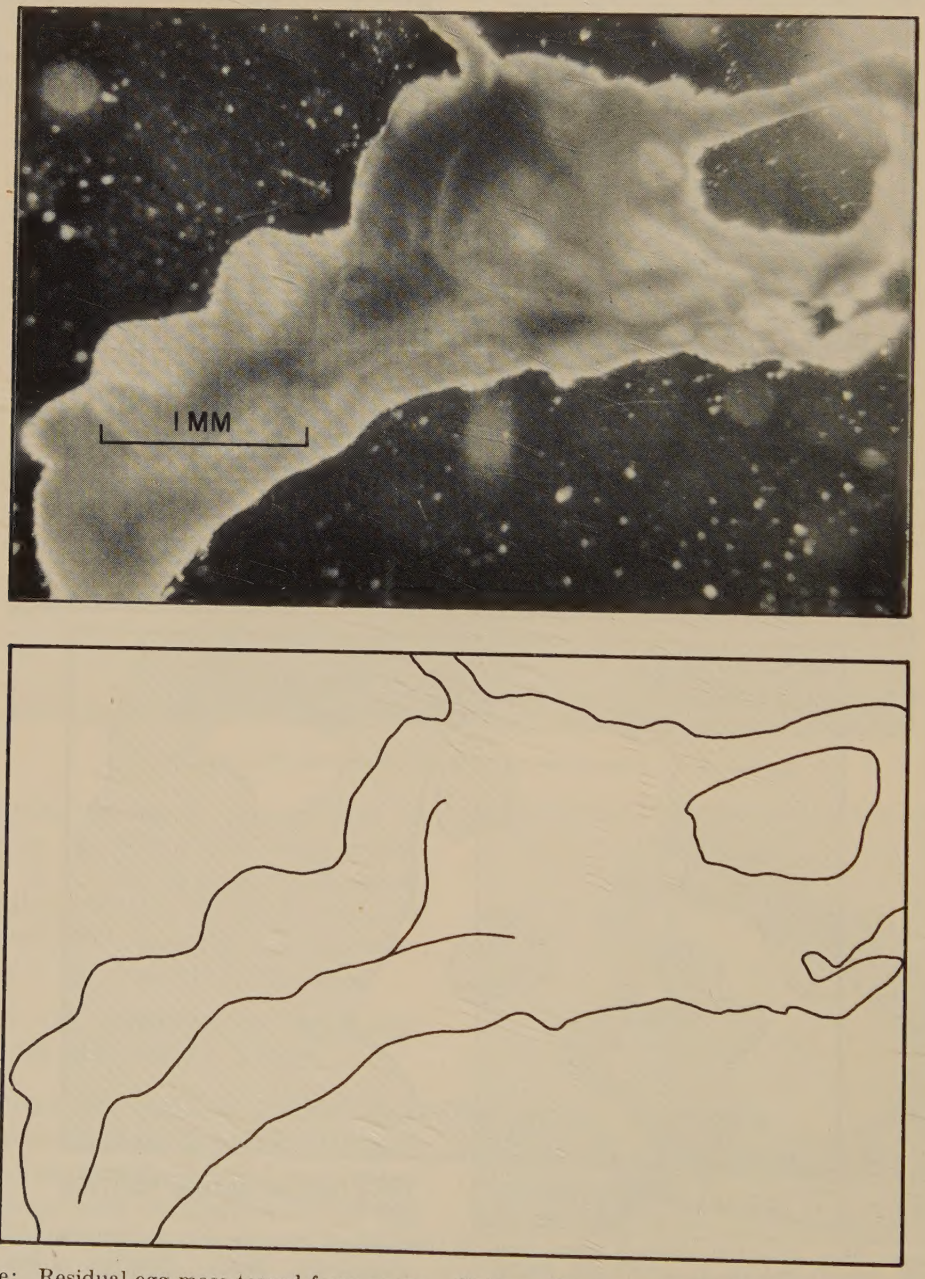

FIGURE 6.—Above: Residual egg mass teased from ovary. Below: Diagram of this mass, outlining the rows of eggs.

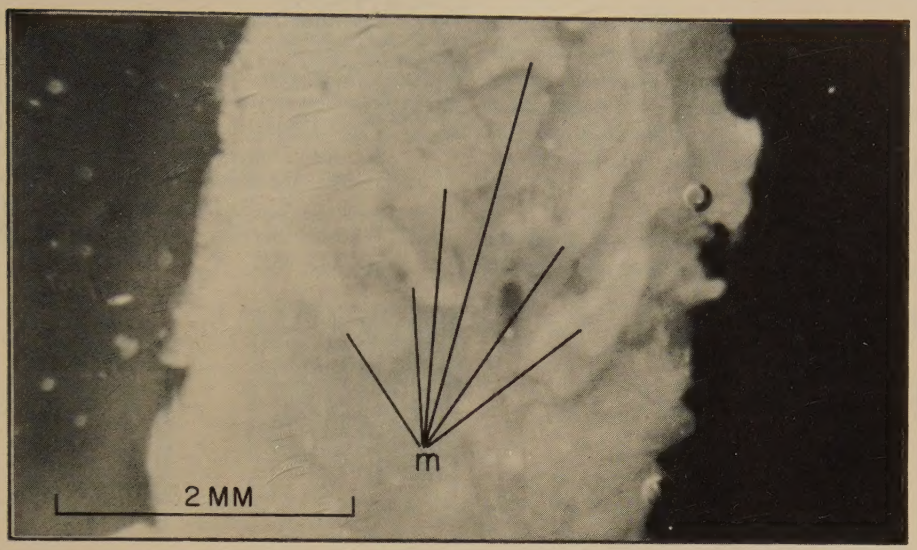

FIGURE 7.—Part of ovary showing shrunken masses of residual eggs; m., mass of residual eggs.

unctioning of the ovaries. There were seldom nore than five worms in a single ovary, and in nly one instance did the ovarian tissue seem to e pathological owing to heavy infestation. Fish vith infested ovaries were found throughout the entral equatorial Pacific.

SUMMARY

This study is based on data obtained in the field elative to the time and place of spawning and he size of yellowfin tuna at time of spawning, nd on laboratory examination of ovaries of yellow- n tuna obtained on POFI exploratory-fishing rips made in the central equatorial Pacific from 'ebruary 1950 to June 1954. Study of the ovaries nd of the data on the size and distribution of the pawning fish led to the following conclusions: 1) The size at sexual maturity may be as small as 0 cm., but usually is greater than 120 cm.; (2) he spawning season extends throughout most of he year, with November, December, and January he months of lowest spawning intensity; (3) the pawning grounds seem to include the entire quatorial Pacific.

During the course of this investigation, stages n the resorption of residual eggs were observed and escribed.

Unidentified nematodes were found in 88 percent of a sample of 25 ovaries. In most instances, the nematodes did not seem to be present in sufficient numbers to affect egg production seriously.

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